

Aug. 16, 1966

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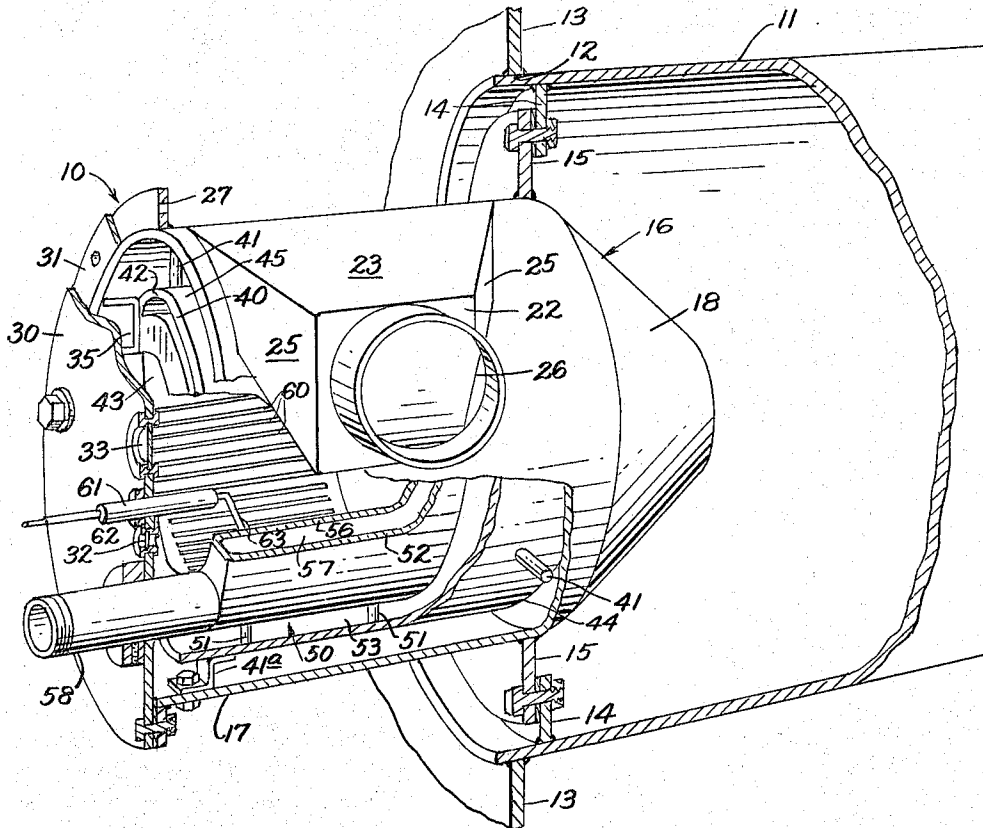
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GAS BURNER

Filed July 3, 1964

4 Sheets-Sheet 1

Fig. 1.



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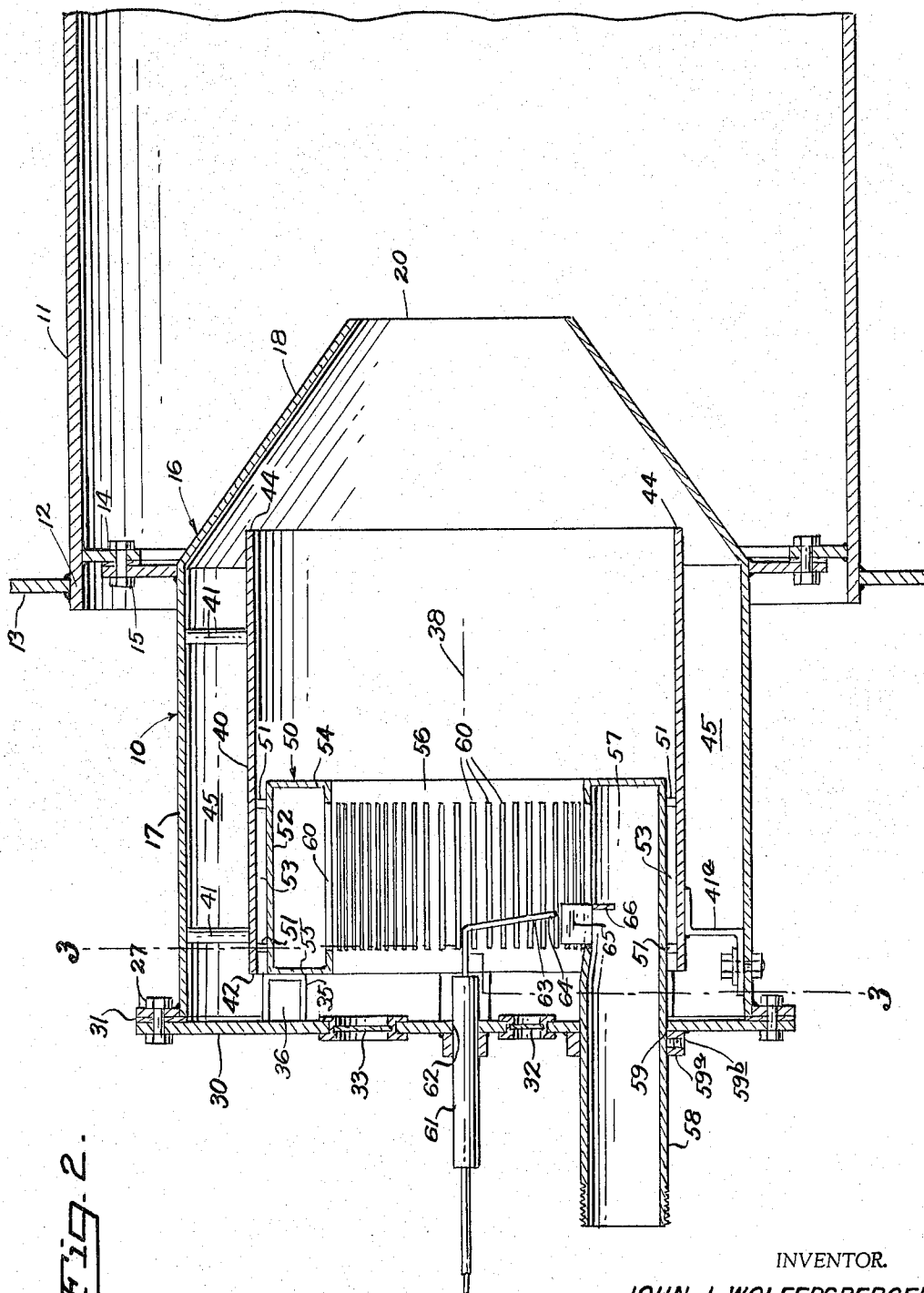
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

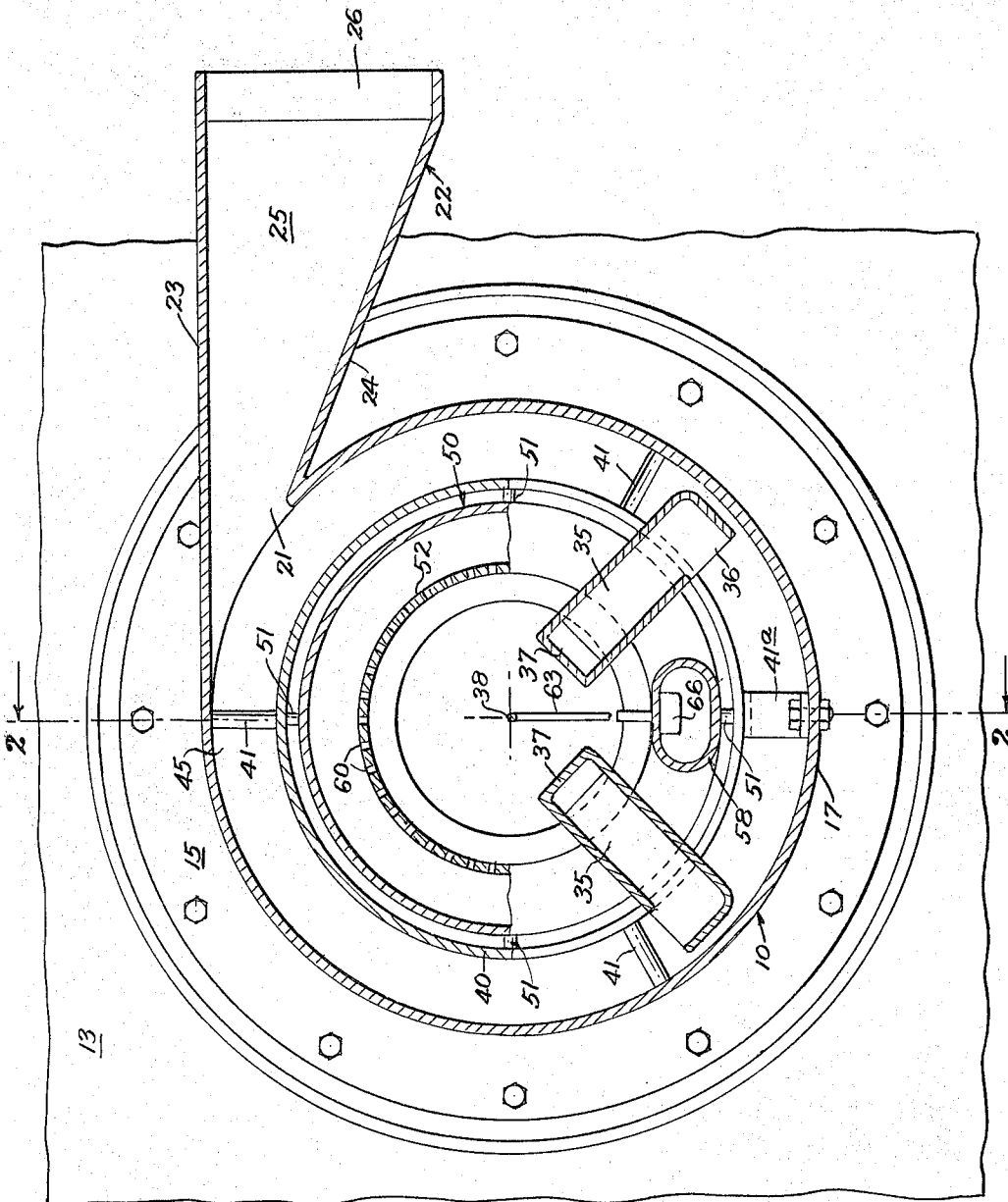


Fig. 3-

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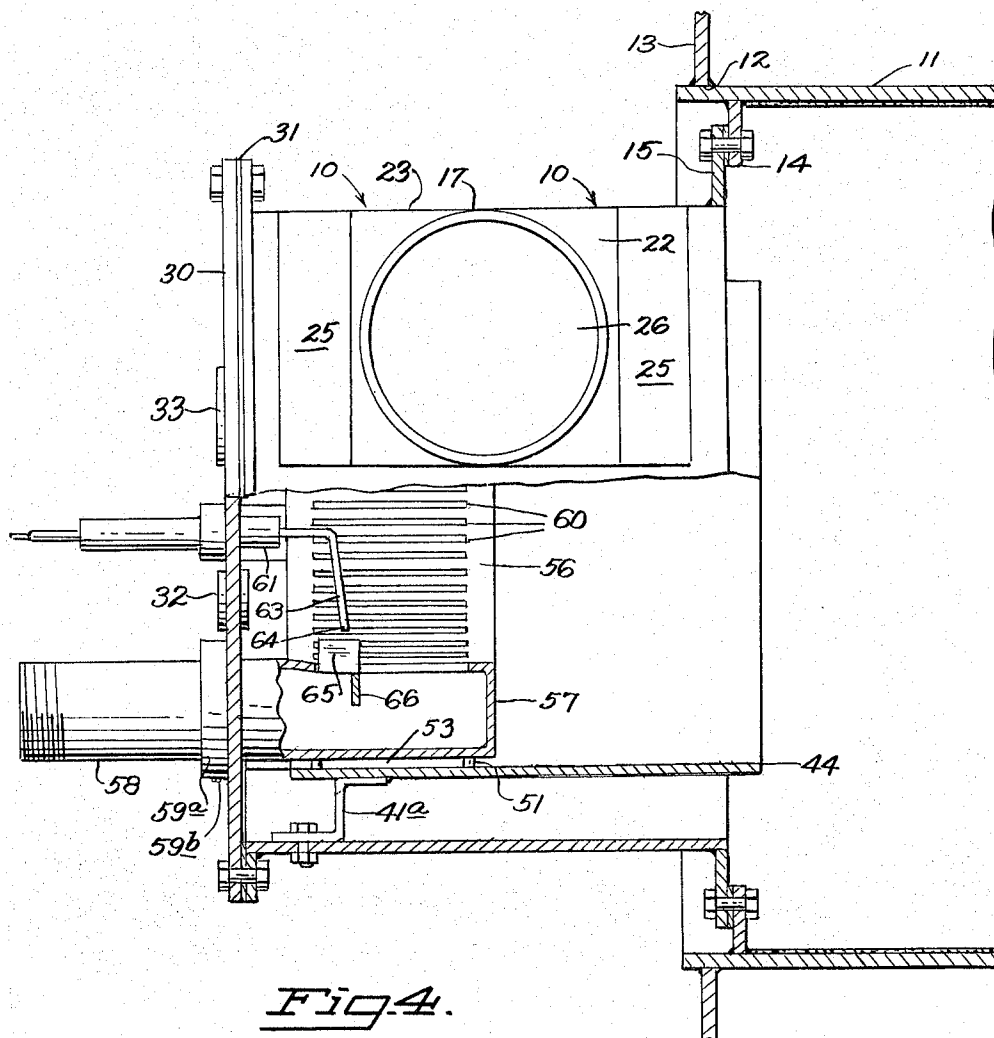
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Filed July 3, 1964

4 Sheets-Sheet 4



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GAS BURNER

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Mill Valley, Calif.Filed July 3, 1964, Ser. No. 380,142
18 Claims. (Cl. 158-1.5)

This invention relates to an improved gas burner, more particularly of the type used with boilers and similar apparatus. It also relates to an improved method for more efficient burning of gas.

The efficiency of gas burners has been much lower than it should be, due to premature mixture of the combustion air with the gas. Most conventional burners envelop the initial flame with the entire supply of combustion air, and this cools the initial flame, slowing down the combustion process considerably in comparison with what it would be if the air were supplied in a more gradual or step-wise manner. For best results, the combustion air should be fed to the growing flame only as fast as the flame can use it. Yet apparatus for accomplishing this desirable result has been lacking or has been unsatisfactory.

Another problem with gas burners for boilers has been basically due to the same cause. This problem has been that of excessive length. As a result of the improper or inefficient mixture of combustion air with the gas, a very long fire tube was needed in order to achieve complete burning, and the flame extended over a considerable distance. These long tubes have consumed a great deal of space, and the boiler and burner combination has had to be excessively long in order to achieve proper heat exchange and to insure that the gas is completely burned.

An object of the present invention is to provide a superior gas burner which achieves complete burning of the fuel within a short space and does so in an efficient manner conducive to the maximum production of heat from the flame. The combustion air is fed to the flame in several steps, achieving an approximation of providing the gas with air in the proportion which the flame requires and as the flame needs the additional air.

Another object of the invention is to provide a burner unit which itself is kept cool and therefore does not require outer insulation or inner refractory lining, though it feeds gas to a very hot flame and sends more heat than has been normal into a fire tube.

Another object of the invention is to rapidly heat the initial flame and to keep the flame temperature hot while feeding combustion oxygen to it.

Another object is to provide a rapid build-up of turbulence after ignition, this being done by directing radially numerous high-velocity thin sheets of flowing gas toward a center axis, while providing an axial and whirling flow of air, so that there is a very turbulent concentrated flame core around the horizontal axis.

Other objects and advantages of the invention will appear from the following description of a preferred embodiment thereof.

In the drawings:

FIG. 1 is a fragmentary view in perspective and partly in section of a gas burner embodying the principles of the invention. The burner is shown installed at one end of a boiler fire tube, the tube sheet and fire tube being broken off in order to conserve space.

FIG. 2 is a view in elevation and in section of the apparatus of FIG. 1 taken along the line 2-2 in FIG. 3.

FIG. 3 is a view in cross section taken along the line 3-3 in FIG. 2.

FIG. 4 is a view similar to FIG. 2 of a modified form of the invention.

The drawings show a burner 10 mounted in one end of a cylindrical fire tube or furnace 11 of a boiler, the furnace 11 being mounted in an opening 12 of a tube

2

sheet 13 of the boiler. The furnace or fire tube 11 is provided with a burner mounting flange 14 to which is bolted (or otherwise secured) a mating radially extending flange 15 that extends out radially from the exterior wall of the burner unit 10.

The burner unit 10 is provided with an outer shell 16 having a cylindrical portion 17 and a frustoconical portion 18 meeting the cylindrical portion 17 at the flange 15. The frustoconical portion 18 preferably extends into the fire tube 11 and is provided with an outlet opening 20 from which the flame issues into the furnace 11. With the present invention, the flame need only extend the outlet 20 for a distance about the same as the length of the outer shell 16, the gas being entirely burned within about that additional length of travel beyond the outlet 20.

The cylindrical shell portion 17 is provided with an air inlet opening 21, and the air is supplied from a fan or other pressure device (or induced draft, if desired) to this opening 21 tangentially by means of an air inlet fitting 22 which has an upper tangential wall 23 and a lower wall 24 which converges toward the wall 23 as they approach the inlet opening 21. Diverging side walls 25 of the fitting 22 lead from a tubular inlet 26 to the inlet opening 21.

An end plate 30 is secured to a flange 27 at the inlet end of the shell portion 17 with proper gasketing 31 between them. The end plate 30 is provided with suitable sight glasses 32 and 33, one for observing the ignition point and another for observation of the normal operating flame. It is also provided with suitable openings for some other members that will be described. In addition, it forms the end wall of a series of (e.g., four) radially extending air scoops 35 which are shaped to provide radially extending openings 36 that pick up air at the outer periphery of the cylindrical shell portion 17 and then conduct the air radially inwardly and eject it in a generally axial direction through openings 37 which are fairly close to the center line or axis 38 of the shell 16. These air scoops 35 provide a generally axial flow of air centrally through the burner unit 10.

A cylindrical sleeve 40 is mounted concentrically within the cylindrical portion 17 by means of a series of radially extending pins 41 and a bracket 41a. At the burner inlet end, the edge 42 of the sleeve 40 preferably abuts the air scoops 35 and provides in between them a series of spaces 43 by which air can pass in toward the axis 38 by a different route. At its other end, the sleeve 40 stops at an edge 44 which is preferably axially beyond the flange 15 as shown in FIG. 2. The edge 44 may be about 1 1/16" axially from the frustoconical portion 18, for example, in a 60 H.P. burner. Thus, air coming in through the opening 21 enters an annular air duct 45 between the sleeve 40 and the cylindrical shell portion 17. Since the air enters the duct 45 tangentially, it tends to whirl around in it, and a whirling motion is imparted to it that continues when it leaves at both ends, 42 and 44. This whirling motion increases turbulence and, as will be seen, thereby improves the efficiency of combustion. Some of this air from the duct 45 enters the inlet 36 for the air scoops 35, as just described; some of the air also passes radially inwardly via the spaces 43 while whirling. Other portions of the air leave the space 45 at the end 44 and whirl against the frustoconical wall 18 or in the space defined by it, forming an air envelope about the flame. This air envelope, in turn, air-cools the frustoconical wall 18, preventing overheating of the wall 18 by the flame. The air in the space 45 also aids in cooling the portion of the sleeve 40 extending beyond the gas tube 50.

An annular gas tube 50 is also located concentrically with respect to both the cylindrical sleeve 40 and the shell 16. A series of short pins 51 supports the gas tube 50 inside the sleeve 40, preferably spacing it only about one-

quarter inch from the sleeve 40, in a burner of 60 H.P. capacity. Thus, between an outer wall 52 of the gas tube 50 and a sleeve 40 there is an air passage 53 which serves two purposes. For one thing, it aids in keeping the sleeve 40 cool beyond the gas tube 50, as a result of the air envelope it forms about the flame, since circulating cool air is passing through this insulating space from the end closest to the end plate 30 toward the outlet opening 20. This space 53 also provides another source of combustion air some of which is fed to the flame as the flame leaves the end wall 54 of the gas tube. The gas tube 50 is substantially shorter than the sleeve 40, and the end wall 54 is axially spaced a substantial distance from the edge 44. Here, again, a whirling current of air is fed to the flame, and it is fed to it after the initial feeding of air and before the air comes off the edge 44 of the sleeve from the air duct 45.

The gas tube 50 has, in addition to the outer wall 52 and the end wall 54, another end wall 55 and an inner cylindrical wall 56. In between the inner and outer walls 56 and 52 of the gas tube 50 is a gas manifold passage 57 into which a gas supply tube 58 leads. Preferably the tube 58 extends axially and leads in through a suitable collar 59a and an opening 59 in the end plate 30, with a set screw 59b in the collar 59a for forward and back adjustment of the gas tube 50. The gas tube 50 is centered by the pins 51 so that it can be adjusted forward and back in order to achieve the best results. Typically, the end wall 55 will rest against the air scoops 35, or close to them, but this may be adjusted if desired.

A feature of this invention is that the inner wall 56 is provided with a series of axially extending radially directed slots 60. As an example, the slots 60 may be about $\frac{1}{16}$ " wide, and they may be spaced about $\frac{1}{4}$ " apart all around the circumference. Gas pressure definitely imparts a radial flow to the gas through the slots 60 toward the center of the gas tube 50.

An ignition electrode 61 extends through an opening 62 in the end plate 30 and is provided preferably with a single wire 63 that is bent down so that its end 64 is in close proximity to one of the radial slots 60 and fairly near its end wall 55. A baffle 65, which may be of $\frac{1}{16}$ " metal wedged into the end of the lowest slot 60, projects up vertically a short distance and decelerates and deflects some of the whirling air to a slow radial ripple or flow, cooperating with the baffle 66 which depends from the wall 56 just below the baffle 65 at its inner end, helping to sweep gas up into the slots 60 on each side of the baffle 65 and thereby provide the properly enriched mixture for a dependable initial ignition. The combination of diversion of gas into the slots 60 closest to the baffle 65 and the diversion of air into this gas, makes ignition simpler and quicker and positively dependable for starting ignition of the gas for the entire burner.

During operation, gas enters the supply tube 58, passes into the manifold passage 57, and is distributed around inside the gas tube 50, there being sufficient pressure to provide an even distribution. The gas then issues radially through the long axially extending radial slots 60 and passes in thin sheets toward the center or axis 38 of the burner unit 10.

Meanwhile, air enters the air inlet tube 26 and flows through the air inlet opening 21 into the air duct 45. Some of this air enters the air scoops 35 and passes radially into a point approximately near the axis 38 of the burner. Another portion of the air passes radially inwardly via the spaces 43 between the air scoops 35, and thence part of it flows into the space 53 between the sleeve 40 and the outer gas tube wall 52, while another part of it passes into the interior of the gas tube 50, whirling and flowing fairly close to the inner wall 56. This air is the initially burned portion, and then as the flame burns inwardly, it begins to consume the air supplied by the air scoops 35. Since the air-scoop air flows substantially axially while the other adjacent air is whirling, a turbu-

lence is set up which improves the burning efficiency and enables the combustion air to gain the necessary access to the unburned gas. Also, the axial movement of both these air currents sends the flame in the proper axial direction toward its eventual outlet opening 20.

As the burning mixture passes beyond the end wall 54 of the gas tube 50, it encounters additional air which has passed through the passage 53 and this additional air forms an envelope of air around the flame between the flame and the sleeve 40, aiding in keeping the sleeve 40 cool. This additional air is thus fed to the flame at the proper time so that it can be used to continue the burning process. As the flame moves further axially, it meets the final split or fraction of air at the very time when it is ready for it. This final split of combustion air has passed from the duct 45 and is now moving frustoconically at a rapidly increasing velocity while being whirled spirally; its turbulent path assures good mixture. Since it reaches the flame just when the flame needs additional air, combustion is rapid and efficient.

Combustion continues on beyond the outlet opening 20 for about a distance equal to the length of the shell 16, as the flame burns inside the fire tube 11. This is a very short length when compared with prior art devices. For example, the cylindrical portion may be only one foot long, the frustoconical portion about another five and a half inches long, and the combustion may be complete within about eighteen inches after leaving the nozzle outlet 20. This is a small fraction of the combustion space that is furnished by conventional boilers and means, for example, that a 60-horsepower burner of this invention can be used in a conventional boiler unit designed for 25-horsepower output and this boiler can thus produce 60 horsepower, which is 240% of its intended use, and it does this very efficiently.

Just as examples of some typical proportions, the gas tube 50 may have an inner diameter of about six inches and an outer diameter of about nine and one-half inches and may be about four and a half or five inches long. The sleeve 40 may be about twelve inches long, the cylindrical portion 17 may be about twelve inches long, as stated. The space 53 may be about one-quarter inch wide, and the air duct 45 may be about one inch wide. These dimensions are changed, of course, in the design of larger and smaller capacity burners, and the burner unit 10 may be designed to handle a very wide range of capacities.

FIG. 4 shows a modified form of the invention, the only change being the absence of the frustoconical wall 18. The wall 18 is a good feature is a good feature and helps a great deal in shortening the flame length, but where there is no demand for such a short flame, the wall 18 is not necessary. It should also be noticed that the gas tube 50 itself can be used in other environments with good effect.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. A gas burner for use with boilers and the like, including in combination:

an outer shell having a generally cylindrical portion, and an axial outlet, said cylindrical portion having an air inlet opening.

a cylindrical sleeve supported concentrically within said cylindrical portion and spaced radially therefrom to define an annular air flow duct in communication with said air inlet opening,

an end plate closing one end of said burner and of said cylindrical portion, said sleeve being spaced

5

axially therefrom to provide for radial inward passage of air from said duct,

an annular gas tube having an axial length shorter than said sleeve and mounted concentrically within said sleeve and spaced therefrom to provide a narrow annular air passage therebetween, said tube having an inner cylindrical wall with a series of narrow axially extending radial slots spaced around its circumference for projecting gas radially toward the axis of the burner, and

a gas supply conduit leading into said tube.

2. The burner of claim 1 having a plurality of radial air scoops at said end plate leading radially in from said air inlet duct, each having an axial outlet near the axial center line of said burner.

3. The burner of claim 1 having a short radially extending baffle in one said slot at the end near said end plate, and ignition means terminating close to said baffle.

4. The burner of claim 3 having a short second baffle in line with said supply conduit and inside said gas tube extending from said inner cylindrical wall from directly beneath the end of said radially extending baffle more distant from said end plate and in a plane perpendicular thereto, to help divert gas up into the two slots closest to said baffle on each side thereof.

5. A gas burner for use with boilers and the like, including in combination:

an outer shell having a generally cylindrical pre-firewall portion and a frustoconical post-firewall portion with an axially aligned nozzle outlet of reduced size, said cylindrical portion having an end edge and having an axially extending tangential air inlet,

a cylindrical sleeve smaller in diameter than the cylindrical portion of said shell supported concentrically within said cylindrical portion and providing with said cylindrical portion an annular air flow duct in communication with said air inlet opening,

an end plate secured to said end edge and closing one end of said burner, said sleeve being spaced therefrom to provide for radial inward passage of air from said duct.

an annular gas tube having an axial length shorter than said sleeve and spaced at about the same distance from said end plate a said sleeve and mounted concentrically within said sleeve, said gas tube being spaced radially in from said sleeve to provide a narrow annular air passage therebetween and having an inner cylindrical wall with a series of narrow axially extending radial slots spaced around the circumference for projecting gas radially toward the axis of the burner, and

a gas supply conduit leading into said gas tube.

6. The burner of claim 5 having a plurality of radial air scoops at said end plate having a radially extending outer opening on one side leading from said air inlet duct radially into a generally horizontal opening near the center of said burner, there also being open space between said scoops for air passage from said duct into said narrow air passage and into said gas tube.

7. The burner of claim 6 having a short radially extending baffle plate positioned in one said slot at the end near said end plate, and an ignition electrode terminating near said baffle.

8. The burner of claim 7 wherein said supply conduit extends parallel to the burner axis, a short second baffle in line with said supply conduit and inside said gas tube and extending from said inner cylindrical wall, said second baffle lying below the end of said radially extending baffle more distant from said end plate and in a plane perpendicular thereto, to aid in directing gas up into the two slots on either side of said baffle.

9. A gas burner for use with boilers and the like, including in combination:

an outer shell having a generally cylindrical pre-firewall

6

portion and a frustoconical post-firewall portion with an axially aligned nozzle outlet of reduced size, said cylindrical portion having an end edge and having an air inlet opening extending in an axial direction along substantially all of said cylindrical portion with outwardly extending walls providing a duct tangential to said shell at said opening,

a cylindrical sleeve smaller in diameter than the cylindrical portion of said shell supported concentrically within said cylindrical portion and spaced axially from both ends thereof, and providing with said cylindrical portion an annular air flow duct in communication with said air inlet opening,

an end plate secured to said end edge and closing one end of said burner, said sleeve being spaced therefrom to provide for radial inward passage of air from said duct,

an annular gas tube having an axial length shorter than said sleeve and spaced in from the end of said sleeve more distant from said end plate and mounted concentrically within said sleeve, said gas tube having an outer cylindrical wall spaced radially from said sleeve to provide a narrow annular air passage therebetween, an inner cylindrical wall joined to said outer wall by end walls and having a series of narrow axially extending radial slots spaced around the circumference for projecting gas radially toward the axis of the burner,

a gas supply conduit leading into the space between said inner and outer walls, and

a plurality of radial air scoops at said end plate leading from said air inlet duct radially in to a point closely adjacent the axial center line of said burner.

10. In a gas burner for use with boilers and the like, the combination of:

an outer shell having a generally cylindrical pre-firewall portion and an axially aligned outlet, said cylindrical portion having an end edge and having an air inlet opening extending in an axial direction along substantially all of said cylindrical portion with outwardly extending walls providing a duct tangential to said shell at said opening,

a cylindrical sleeve smaller in diameter than the cylindrical portion of said shell supported concentrically within said cylindrical portion and providing with said cylindrical portion an annular air flow duct in communication with said air inlet opening,

an end plate secured to said end edge and closing one end of said burner, said sleeve being spaced therefrom to provide for radial inward passage of air from said duct,

an annular gas tube having an axial length shorter than said sleeve and spaced in from the end of said sleeve more distant from said end plate and mounted concentrically within said sleeve, said gas tube having an outer cylindrical wall spaced radially from said sleeve to provide a narrow annular air passage therebetween, an inner cylindrical wall joined to said outer wall by end walls and having a series of narrow axially extending radial slots spaced around the circumference for projecting gas radially toward the axis of the burner, and a gas supply tube leading into the space between said inner and outer walls, and

a plurality of radial air scoops at said end plate leading from said air inlet duct radially in to a point closely adjacent the axial center line of said burner.

11. A method for efficient burning of gas to produce good power output within a small length, comprising the steps of

introducing gas radially inwardly from an annular zone along a substantial length and along narrow axially extending radial jets,

introducing a first supply of combustion air from one axial end of said zone at about the axial centerline thereof,

- introducing a second supply of combustion air in a generally helical path from said one end closer to the inner periphery of the annular zone,
 introducing a third supply of combustion air at the other end of said annular zone in a generally helical path of larger diameter than said annular zone and in the same axial direction as said first and second supplies, and
 introducing a fourth supply of combustion air beyond the introduction of said third supply and in the same axial direction from a larger diameter than said third supply.
12. A method for efficient burning of gas to produce good power output within a small length, comprising the steps of
 introducing gas radially inwardly from an annular zone along a substantial length and along narrow axially extending radial jets,
 introducing a first supply of combustion air from one axial end of said zone at about the axial centerline thereof,
 introducing a second supply of combustion air in a generally helical path from said one end closer to the inner periphery of the annular zone,
 introducing a third supply of combustion air at the other end of said annular zone in a generally helical path of larger diameter than said annular zone and in the same axial direction as said first and second supplies, and
 introducing a fourth supply of combustion air beyond the introduction of said third supply and in the same axial direction along a frustoconical path from a larger diameter than said third supply to a smaller diameter than said second supply.
13. A gas burner for use with boilers and the like, including in combination:
 an outer shell having a generally cylindrical portion, and an axial outlet, said cylindrical portion having an air inlet opening,
 an end plate closing one end of said burner and of said cylindrical portion,
 an annular gas tube having an axial length shorter than said cylindrical portion and mounted concentrically within it, said tube having an inner cylindrical wall with a series of narrow axially extending radial slots spaced around its circumference for projecting gas radially toward the axis of the burner, and
 a gas supply conduit leading into said tube.
14. The burner of claim 13 having a plurality of radial air scoops at said end plate leading radially in from beyond said gas tube, each having an axial outlet near the axial center line of said burner.

15. A gas burner for use with boilers and the like, including in combination:
 an outer shell having a generally cylindrical pre-firewall portion and a frustoconical post-firewall portion with an axially aligned nozzle outlet of reduced size, said cylindrical portion having an end edge and having an axially extending tangential air inlet,
 an end plate secured to said end edge and closing one end of said burner,
 an annular gas tube having an axial length shorter than said cylindrical portion and spaced away from said end plate and mounted concentrically within said cylindrical portion, said gas tube being spaced radially in from cylindrical portion to provide an annular air passage therebetween and having an inner cylindrical wall with a series of narrow axially extending radial slots spaced around the circumference for projecting gas radially toward the axis of the burner, and
 a gas supply conduit leading into said gas tube.
16. The burner of claim 15 having a plurality of radial air scoops at said end plate having a radially extending outer opening on one side leading from said air passage radially into a generally horizontal opening near the center of said burner, there also being open space between said scoops for air passage into said gas tube.
17. A gas burner for use in gas furnaces, including in combination:
 an annular gas tube having an inner cylindrical wall with a series of narrow axially extending radial slots spaced around its circumference for projecting gas radially toward the axis of the tube,
 a gas supply conduit leading into said tube,
 a radially extending baffle plate in one end of one said slot, and
 ignition means terminating close to said baffle plate.
18. The burner of claim 17 having a second baffle plate lying in a plane perpendicular to said radially extending baffle plate at the end thereof away from the end of said slot and located inside said gas tube, extending from said inner cylindrical wall, said conduit leading into said gas tube parallel to the axis thereof and directly toward said second baffle plate.

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